REMARKS

In view of the foregoing amendments and following remarks, reconsideration of this application and early allowance of the application is respectfully requested.

Claims 1, 2, 13, 15, 33-35 and 38 stand rejected under 35 U.S.C. § 102(b) for the reasons stated on pages 2-4 of the Office Action. Also, claims 3-12, 14, 16-19, 27-29, 31, 32, 36 and 37 stand rejected under 35 U.S.C. § 103(a) for the reasons stated on pages 4-11 of the Office Action. Claims 20-26 and 30 are objected to as being dependent upon a rejected base claim, but the Examiner notes that these claims would be allowable if rewritten in appropriate independent form.

Claims 2, 6, 9-12, 14, 36 and 38 have been canceled without prejudice. Claims 1, 7, 13, 16, 20-26, 30, 33 and 37 have been amended (claims 7 and 16 being amended to provide for appropriate claim dependency given the cancellation of claims 6 and 14). New claim 39 has been added. No new matter has been introduced.

Claims 20-26 and 30 have been rewritten in appropriate independent form. Accordingly, it is believed that claims 20-26 and 30 are now in condition for immediate allowance, and notice to this effect is requested.

As set forth in detail in the specification and drawings of the present application, Applicants' invention is directed to embodiments of a tire pressure monitoring method and system for a vehicle equipped with an anti-lock braking system (ABS). ABS wheel sensors sense variables which depend on travel distances covered by the vehicle wheels. The travel distances are determined simply by counting the periods of the sensor signals. An ABS control unit adds the variables of the individual wheels on the respective diagonals relative to the wheel arrangement of the vehicle. Recognition of an undesired (insufficient) tire pressure condition

takes place when the diagonal sums differ from one another by more than a preselected limit value. Furthermore, monitoring of the variables takes place in a plurality of monitoring cycles, recognition of an undesired tire pressure condition taking place when the deviations of the diagonal sums exceed a limit value defined for all monitoring cycles. In addition, a direct tire pressure monitoring system can be employed to detect decreases in tire pressure and to corroborate the values determined indirectly by means of the ABS.

Applicants have amended independent claims 1, 13 and 33 to more particularly point out and distinctly claim the foregoing method and system. Particularly, claim 1 now clearly recites the steps of sensing wheel sensor signal pulses associated with wheel rotation of the vehicle wheels and determining travel distances covered by the wheels by counting the wheel sensor signal pulses; claim 13 now clearly recites means for directly measuring tire inflation pressure to corroborate change in sensed attributes associated with wheel rotation caused by tire pressure decrease; and claim 33 now clearly recites the steps of measuring tire inflation pressure using a tire pressure measuring apparatus, comparing the tire inflation pressure with a preselected setpoint pressure and recognizing an insufficient tire pressure condition if the sums of values associated with wheel rotation for diagonal wheel groupings differ by more than a preselected limit value and/or the difference between the tire inflation pressure and the setpoint pressure exceeds a preselected threshold value. Claim 37 has also been amended to recite the steps of sensing wheel sensor signal pulses associated with wheel rotation of the vehicle wheels and determining travel distances covered by the wheels by counting the wheel sensor signal pulses.

Turning now to the rejections of claims 1, 2, 13, 15, 33-35 and 38 under 35 U.S.C. § 102(b), as now explained, a review and reading of the cited patents makes clear that the

patents do not disclose or yield Applicants' method and system as presently claimed. Applicants respectfully submit that differences exist between the method and system claimed in the present application and the methods and systems disclosed in the cited art that warrant the immediate withdrawal of the claim rejections on anticipation grounds. The cited art does not disclose each element of the rejected claims.

The Examiner has specifically rejected claims 1, 2, 13 and 15 under 35 U.S.C. § 102(b) as being anticipated by Boesch et al. U.S. Patent No. 5,721,528. Applicants respectfully traverse these claim rejections.

Regarding claim 2, as this claim has been canceled from the present application without prejudice, the rejection of the claim is now moot.

The Boesch patent cited by the Examiner describes a method and system for detecting low tire pressure utilizing four wheel displacement sensors. The wheel displacement sensors measure the angular displacement of each wheel. Velocity values are calculated from these measurements. These velocity values are accumulated as displacement values until a predetermined distance is reached (column 4, lines 14-40). The "displacement" calculated according to Boesch is essentially an integral of velocity values over time.

The Boesch approach introduces undesirable inaccuracies that are avoided by the present invention.

Typically a microprocessor is used to process signals from sensors. The microprocessor processes the signal values by using a digital representation. Because a microprocessor is able to represent the digital signals with only a limited resolution (i.e., limited number of bits), and sometimes simple integer calculation is used rather than floating point calculation, each additional processing step can result in additional inaccuracies in the calculated

results. Therefore, in order to obtain a more accurate result, as recognized by the present invention, it is desirable to use as few calculation steps as possible. In addition, there is a reciprocal relationship between the signal periods of pulsed signals and velocity, and, accordingly, the calculation of a velocity value from a pulsed sensor signal requires a mathematical step of division of two values. Such a division step is particularly inaccurate when performed by the microprocessors typically used in ABS systems.

At the same time, a high degree of accuracy of signal processing is necessary in order to monitor tire pressure and detect low tire pressure from the signals of wheel sensors. A change in tire pressure produces only very slight changes in the rolling radius of the tire, which are difficult to measure by the wheel sensors.

With the foregoing in mind, it can be appreciated that the calculation of tire pressure from a computed velocity value as described in Boesch is undesirably inaccurate.

In contrast to and avoiding the disadvantages of Boesch, an embodiment of Applicants' invention is concerned with calculating travel distance by incrementing a count register each time a wheel sensor voltage passes through zero. Thus, the travel distance can be determined simply and accurately by counting the periods of the sensor signals.

Independent claim 1 in the present application, as presently amended, clearly recites the steps of sensing wheel sensor signal pulses associated with wheel rotation of each of the vehicle wheels and determining travel distances covered by each of the wheels by counting the wheel sensor signal pulses for each of the wheels. Accordingly, claim 1 recites features nowhere found in the Boesch reference, and the Boesch patent cannot anticipate or render claim 1 obvious. Notice to this effect is respectfully solicited.

Independent claim 13, as presently amended, is specifically directed to a tire pressure monitoring system. The system includes a vehicle having a plurality of wheels, a plurality of axles for supporting the wheels, an anti-lock braking system including a control unit, and wheel sensors located on at least one of the wheels for sensing attributes associated with wheel rotation. The control unit is adapted to logically combine and evaluate the attributes. Claim 13, as presently amended, clearly and affirmatively recites means for directly measuring tire inflation pressure of at least one of the wheels to corroborate change of the attributes caused by tire pressure decrease.

In contrast to the present invention as claimed in independent claim 13, the Boesch patent is not concerned with and, accordingly, nowhere describes or suggests providing a combined system employing means for directly measuring tire inflation pressure to corroborate indirect measurements utilizing the wheel sensors. Accordingly, claim 13 recites features nowhere found in the Boesch reference, and the Boesch patent cannot anticipate or render claim 13 obvious. Notice to this effect is respectfully solicited.

Regarding claim 15, this claim depends from independent claim 13 and is allowable by reason of the same distinctions discussed above with respect to claim 13. Claim 15 is also allowable for the additional features recited therein. Notice to the effect that claim 15 is in condition for allowance is also respectfully requested.

Claims 33-35 and 38 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Okawa et al. U.S. Patent No. 5,591,906. Applicants respectfully traverse these claim rejections.

Regarding claim 38, as this claim has been canceled from the present application without prejudice, the rejection of the claim is now moot.

The Okawa patent cited by the Examiner describes a device and method for detecting a tire pressure drop for a four-wheel vehicle. Rotational angular velocities are measured for all four tires. A ratio is then calculated of the sum of the rotational angular velocities for opposing diagonal pairs of wheels. Rotational angular velocity for measuring periods is calculated by dividing the number of pulses during a measuring period by a calculated reference time based on time elapsed from when the last pulse within the preceding measuring period is applied to when the last pulse within the present measuring period is applied to compute the number of pulses per unit time. The rotational angular velocity of the tire is then calculated based on the number of pulses per unit time (column 4, lines 52-67, Figs. 8a, 8b and 10). The counting of pulses in Okawa is merely a sub-procedure for calculating velocity values, and the detection of tire pressure drop is based on velocity values. Thus, Okawa nowhere teaches or suggests determining travel distances covered by the wheels merely by counting wheel sensor signal pulses. Further, Okawa nowhere describes or suggests direct measurement of tire inflation pressure to corroborate indirect measurement utilizing the wheel sensors.

Regarding claim 33 of the present application, as indicated above, claim 33 now clearly recites the steps of measuring tire inflation pressure using a tire pressure measuring apparatus, comparing the tire inflation pressure with a preselected setpoint pressure and recognizing an insufficient tire pressure condition if the sums of values associated with wheel rotation for diagonal wheel groupings differ by more than a preselected limit value and/or the difference between the tire inflation pressure and the setpoint pressure exceeds a preselected threshold value. As claim 33 recites steps and features nowhere found in the Okawa reference, the Okawa patent cannot anticipate or render claim 33 obvious. Notice to this effect is respectfully solicited.

Regarding claims 34 and 35, these claims depend from independent claim 33 and are allowable by reason of the same distinctions discussed above with respect to claim 33. Claims 34 and 35 are also allowable for the additional steps and features recited therein. Notice to the effect that claims 34 and 35 are in condition for allowance is also respectfully requested.

The Federal Circuit has instructed that anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration. *See W.L. Gore & Assocs. v. Garlock, Inc.*, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 841 (1984); *see also Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co.*, 221 USPQ 481, 485 (Fed. Cir. 1984) (requiring that the prior art reference disclose each element of the claimed invention arranged as in the claim). Considering that the method and system of the present invention as claimed in claims 1, 13 and 15 differ from the method and system described in Boesch, and claims 33-35 differ from the method and system described in Okawa, as discussed above, it is respectfully submitted that claims 1, 13 and 15 are patentable over Boesch and claims 33-35 are patentable over Okawa. Notice to this effect is earnestly solicited.

Turning now to the Examiner's rejection of claims 3-12 and 32 under 35 U.S.C. § 103(a) as being unpatentable over Boesch in view of Okawa, Applicants respectfully traverse these claim rejections for the reasons detailed below. Significant differences exist between Applicants' claimed invention and the Boesch and Okawa patents which prevent these patents, whether taken alone or in combination, from disclosing, yielding or even suggesting Applicants' claimed invention.

Regarding claims 2, 6 and 9-12, as these claims have been canceled from the present application without prejudice, the rejections of these claims are now moot.

As discussed above, Boesch does not teach or suggest the method claimed in claim 1 which clearly recites a process for monitoring vehicle tire pressure wherein wheel sensor signal pulses associated with wheel rotation are counted to determine travel distances covered by the wheels. Okawa does not overcome the severe deficiencies of Boesch with respect to claim 1, as Okawa also does not teach or suggest determining travel distances covered by the wheels merely by counting wheel sensor signal pulses. As set forth in the present application, such signal pulse counts avoid the undesirable inaccuracies associated with relying on calculated wheel velocities as taught in both Boesch and Okawa.

In view of the foregoing, it is respectfully submitted that one of ordinary skill in the art who reads and understands Boesch and Okawa would not be inclined, let alone equipped, to arrive at the present invention as claimed in independent claim 1 as amended. Claims 3-5, 7 and 8 depend from amended independent claim 1, and are patentable over Boesch and Okawa for the same reasons that independent claim 1 is patentable over these references. Notice to this effect is earnestly solicited.

Regarding claim 32, similar to independent method claim 1, this system claim is concerned with counting periods of the wheel sensor signals to determine travel distances covered by the wheels -- which is nowhere taught or suggested in Boesch and Okawa which are concerned with monitoring tire pressure based on velocity calculations -- and recites at least one microcontroller as the means for accomplishing such process. Thus, it is submitted that claim 32 is patentable over both Boesch and Okawa, whether taken alone or combined, for the same reasons stated herein with respect to independent claim 1.

Further, Applicants note that claim 32 ultimately depends from independent claim 13. As discussed previously, Applicants amended claim 13 to recite means for directly

measuring tire inflation pressure of at least one of the wheels to corroborate change of the attributes caused by tire pressure decrease. Neither Boesch nor Okawa are concerned with, and consequently do not describe or suggest, direct measurement of tire inflation pressure to corroborate indirect measurement utilizing the wheel sensors. Accordingly, it is submitted that one of ordinary skill in the art who reads and understands Boesch and Okawa would not be inclined, let alone equipped, to arrive at the system according to the present invention as claimed in independent claim 13 as amended. Claim 32 is therefore also patentable over Boesch and Okawa for the same reasons that independent claim 13 is patentable over these references. Notice to this effect is solicited.

Turning now to the Examiner's rejection of claims 14, 16-19, 27-29 and 31 under 35 U.S.C. § 103(a) as being unpatentable over Boesch in view of Achterholt U.S. Patent No. 6,476,712, Applicants respectfully traverse these claim rejections for the reasons detailed below. Significant differences exist between Applicants' claimed invention and the Boesch and Achterholt patents which prevent these patents, whether taken alone or in combination, from disclosing, yielding or even suggesting Applicants' claimed invention.

Regarding claim 14, as this claim has been canceled from the present application without prejudice, the rejection of this claim is now moot.

Applicants note that the Achterholt patent cited by the Examiner is an intervening reference as it has an effective date between the date of Applicants' German Priority Application No. 101 09 725.5 filed on February 28, 2001 and the February 26, 2002 U.S. filing date of the present application. Accordingly, Applicants reserve the right to rely on the German Priority Application to overcome the claim rejections based on Achterholt.

As discussed above, claim 13, as presently amended, clearly and affirmatively

recites that the tire pressure monitoring system includes means for directly measuring tire inflation pressure to corroborate change in sensed attributes associated with wheel rotation caused by tire pressure decrease. The combination of direct pressure and wheel rotation sensors increases the accuracy of the pressure monitoring system and provides the salutary benefit of fault tolerance. Rejected claims 16-19, 27-29 and 31 all ultimately depend from independent claim 13.

Achterholt generally describes a tire pressure display device wherein tire pressure is directly monitored by a electronic module with an integrated pressure sensor coupled to a high-frequency transmitter/receiver capable of communicating with a microprocessor.

While Boesch discloses a pure wheel sensor based tire pressure monitoring system, Achterholt discloses a pure pressure sensor based approach. There is no mention nor suggestion in either reference that a combination of both systems could be advantageous, let alone a teaching or suggestion of how such a combination could be made. Accordingly, one of ordinary skill in the art would not be motivated or equipped to combine Achterholt and Boesch, as Boesch and Achterholt, whether taken alone or in combination, do not yield, teach or even suggest Applicants' combination of a wheel sensor and pressure sensor based arrangement as claimed in independent claim 13.

Claims 16-19, 27-29 and 31 which all ultimately depend from independent claim 13 are therefore also patentable over Boesch and Achterholt for the same reasons that independent claim 13 is patentable over these references. Notice to this effect is respectfully requested.

Claim 36 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Okawa in view of Achterholt. Claim 36 has been canceled without prejudice, and the rejection

of this claim is now moot.

Claim 37 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Okawa in view of Boesch. Applicants respectfully traverse the Examiner's rejection of claim 37 for the reasons detailed below. Significant differences exist between Applicants' claimed invention and the Okawa and Boesch patents which prevent these patents, whether taken alone or in combination, from disclosing, yielding or even suggesting Applicants' claimed invention.

Claim 37 depends from independent claim 33. Claim 33, as presently amended, affirmatively recites the steps of measuring the tire inflation pressure of at least one wheel utilizing a tire pressure measuring apparatus, comparing the measured tire inflation pressure with a preselected setpoint pressure, and generating a warning signal when the sums differ from one another by more than a preselected limit value and/or the difference between the tire inflation pressure and setpoint pressure exceeds a preselected threshold value. Claim 37, as amended, recites that the step of sensing wheel sensor signal pulses associated with wheel rotation for each wheel and counting the signal pulses for each wheel to determine travel distance covered by each wheel.

As discussed above, neither Okawa nor Boesch teach or suggest determining travel distances covered by the wheels merely by counting wheel sensor signal pulses as recited in claim 37. Further, neither Okawa nor Boesch describe or suggest direct measurement of tire inflation pressure to corroborate wheel sensor measurements.

Accordingly, one of ordinary skill in the art would not be motivated or equipped to combine Okawa and Boesch as these references, whether taken alone or in combination, do not yield, teach or even suggest Applicants' invention as claimed in claim 37. Notice to the effect that claim 37 is in condition for immediate allowance is respectfully solicited.

New claim 39 has been added to provide appropriate protection for the present invention. No new matter has been introduced. It is submitted that new claim 39, which depends from claim 37 and, ultimately, from independent claim 33, is allowable for the reasons detailed above regarding claims 33 and 37, as well as for the additional features recited therein. Notice to this effect is respectfully requested.

The references cited by the Examiner but not applied are believed to be merely of interest, and no further discussion of the reference is deemed necessary or appropriate at this time.

In view of the foregoing amendments and remarks, Applicants have made a diligent effort to place this application in condition for immediate allowance, and notice to this effect is earnestly requested. The Examiner is invited to contact Applicants' undersigned attorneys at the telephone number set forth below if it will advance the prosecution of this case.

The $672 fee associated with the amendment of claims 20-26 and 30 into independent form yielding eight independent claims in excess of three is enclosed. Please charge any fee deficiency and credit any overpayment to Deposit Account No. 50-0540.

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